Stanford MicroSats

April 5, 2002
NASA National University Satellite Program

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Stanford University

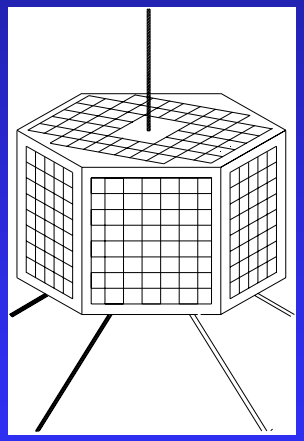
Presentation Outline

- Program Objectives
- Program Accomplishments
- Changes in Program
- Present Projects
- Conclusions

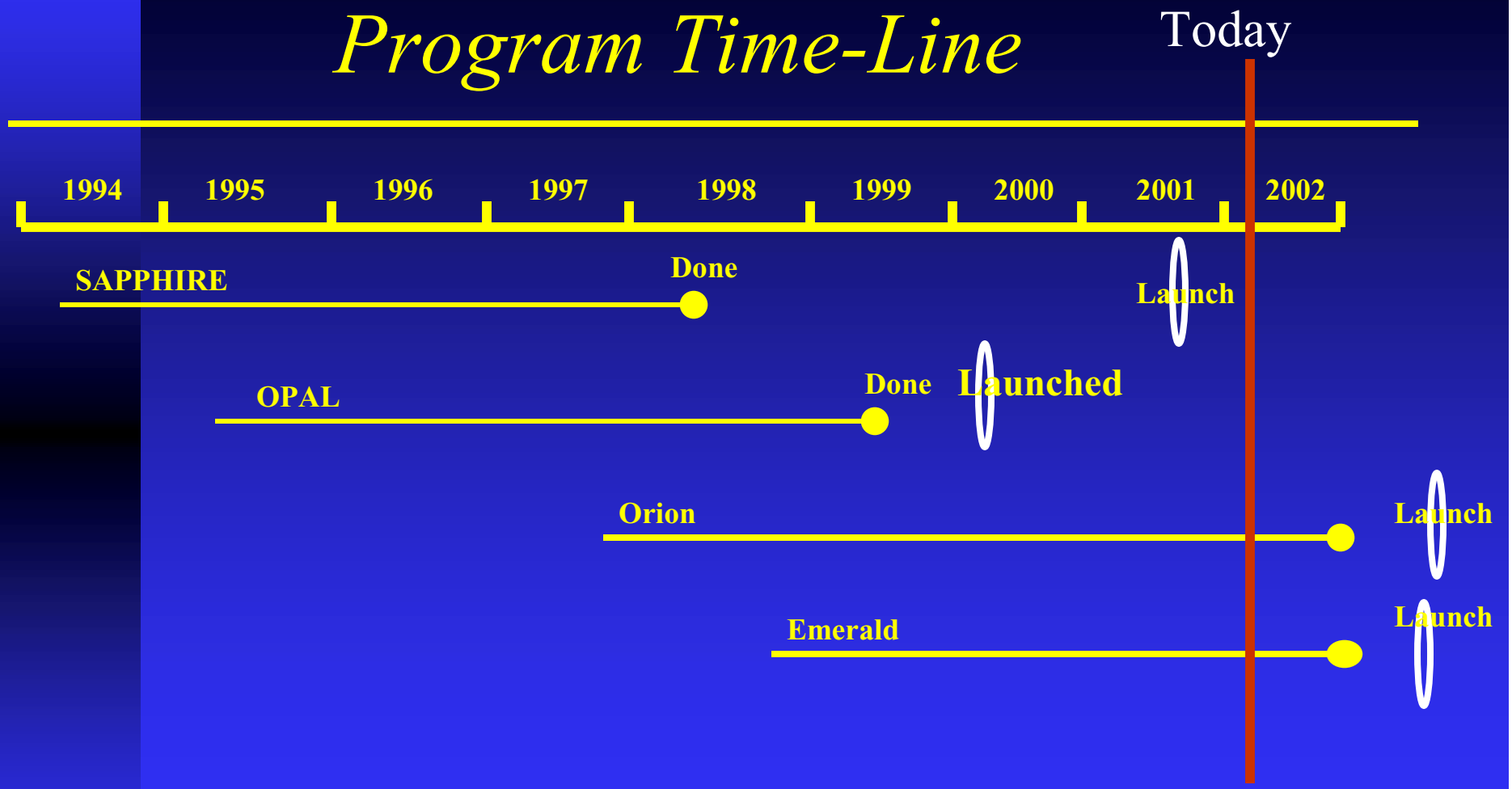
SQUIRT
Design Guidelines -1994

Satellite Quick Research Testbed (SQUIRT)

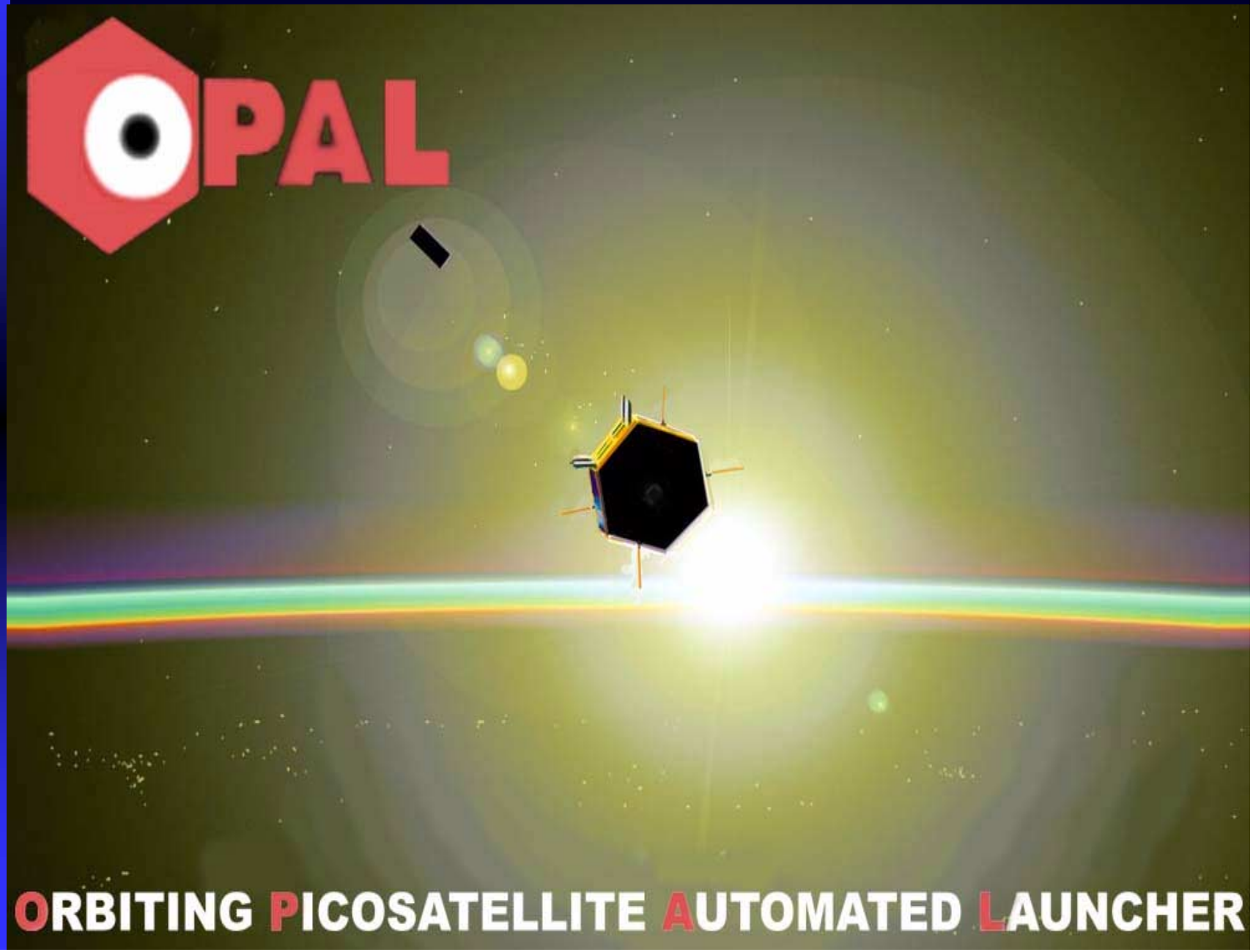
- Student managed project
- One year mission lifetime
- One year development
- $50,000 Cash Budget
- Modular hexagon bus
- Design for many launch vehicles
- Use amateur radio frequencies



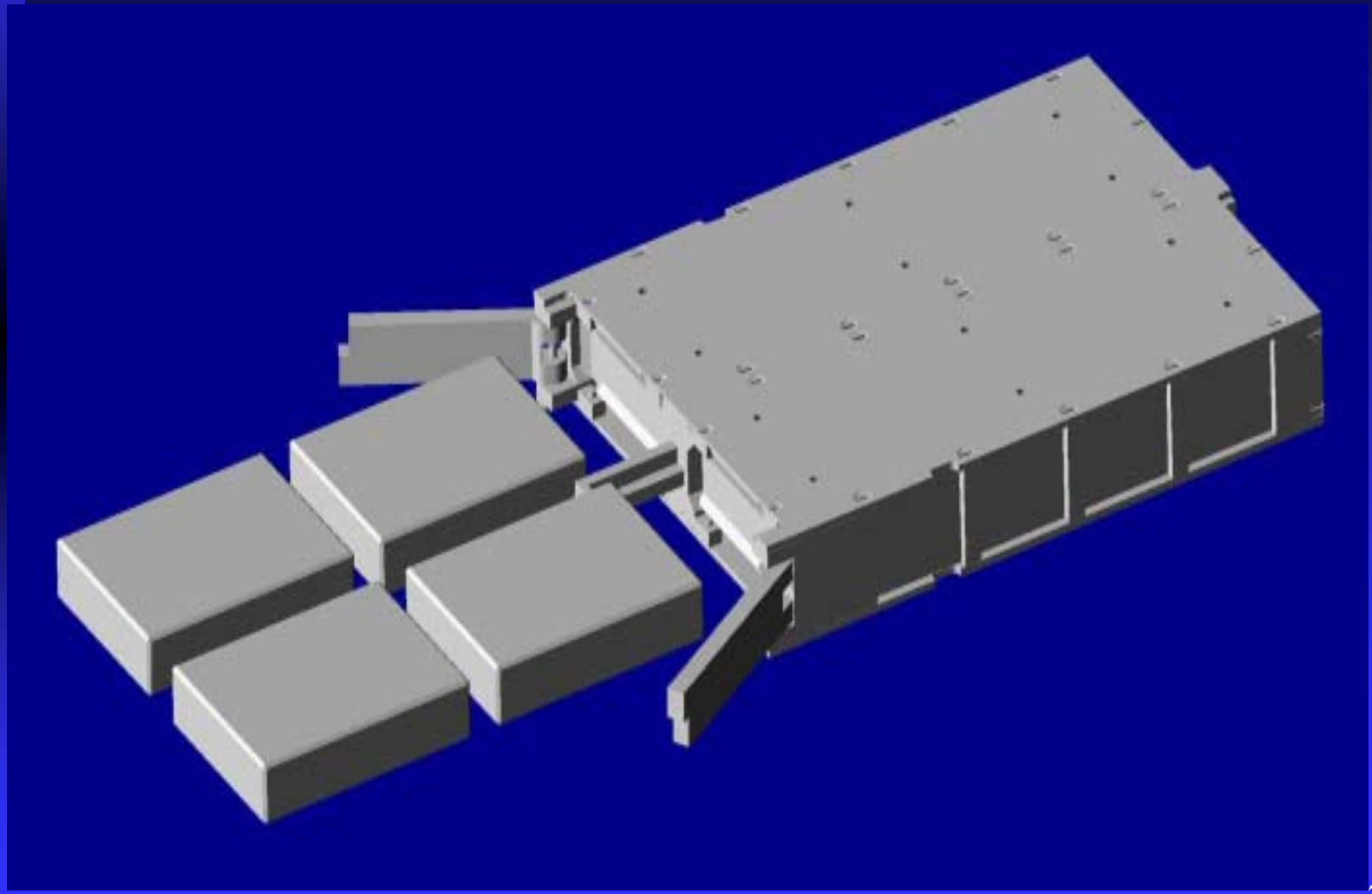
Program Time-Line



Accomplishments


OPAL
ORBITING PICOSATELLITE AUTOMATED LAUNCHER

Picosatellite Launcher



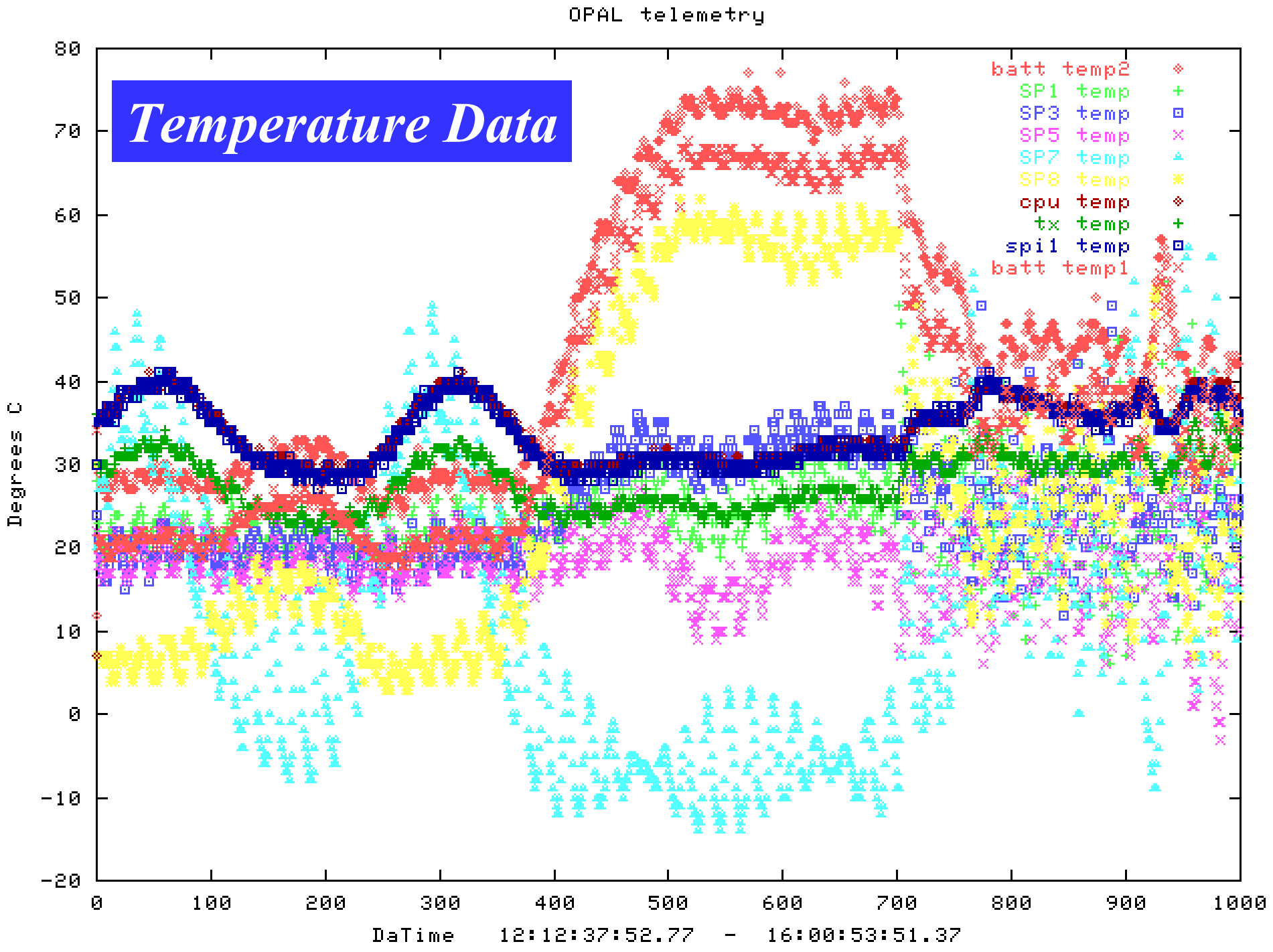

Last Checkout at Vandenberg, AFB

Launch

Operations

At 5am Contact Time

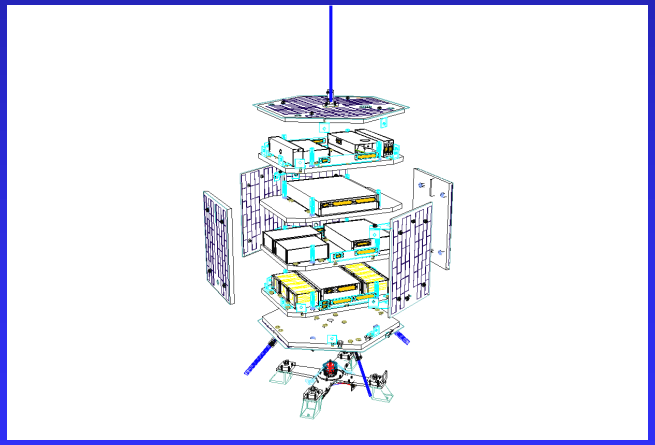
It Works!!!

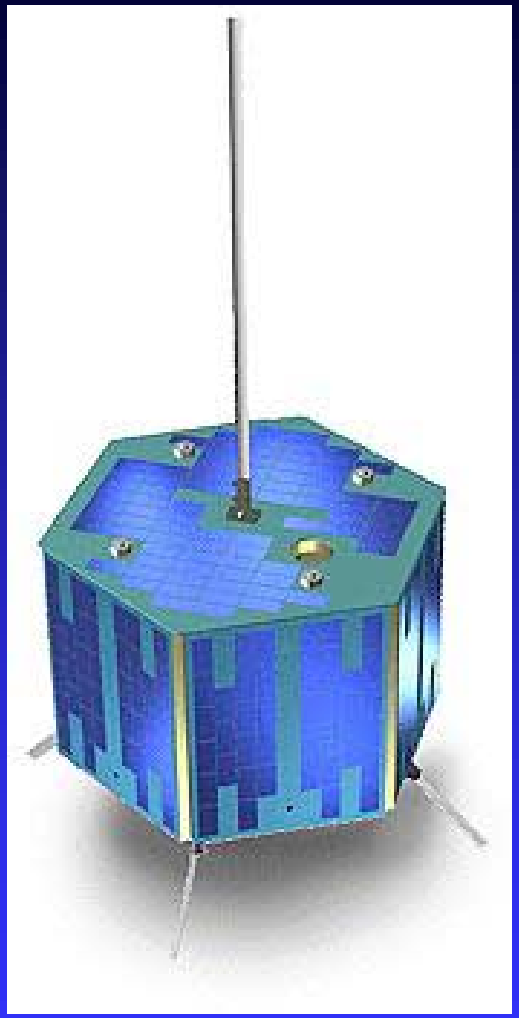

OPAL telemetry
Temperature Data
batt temp2
SP1 temp
SP3 temp
SP5 temp
SP7 temp
SP8 temp
cpu temp
tx temp
spi1 temp
batt temp1
Degrees C
80
70
60
50
40
30
20
10
0
-10
-20
0
100
200
300
400
500
600
700
800
900
1000
DaTime 12:12:37:52.77 - 16:00:53:51.37

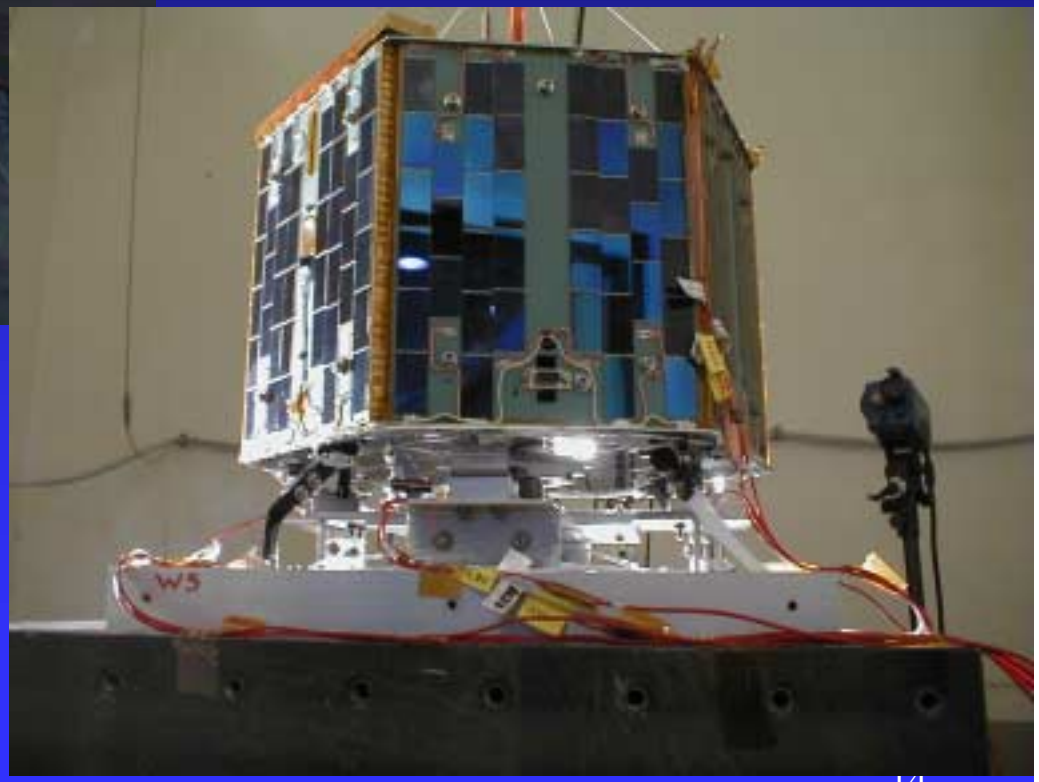
Mission Results

- **Launch Picosats – 100%**
- **Test Magnetometer – 100%**
- **Test Accelerometers – 100%**
- **Education Value – 200%**
- **Student Leaning – One Chance in a Life Time**
- **Still Operational**
- **Started Operations Research –**
  Satellites as IP Nodes

SAPPHIRE



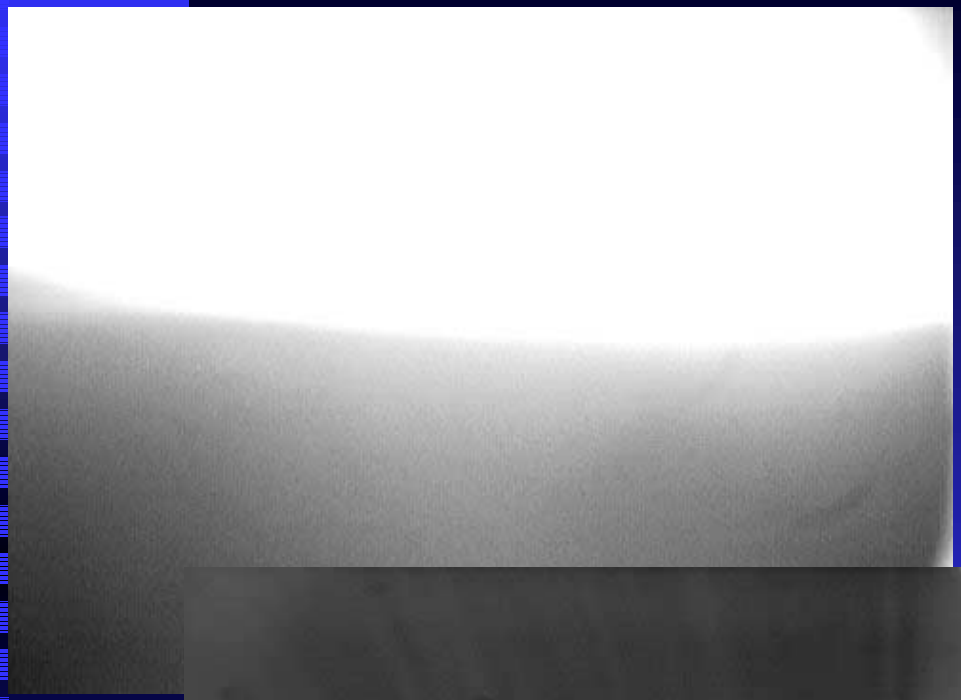




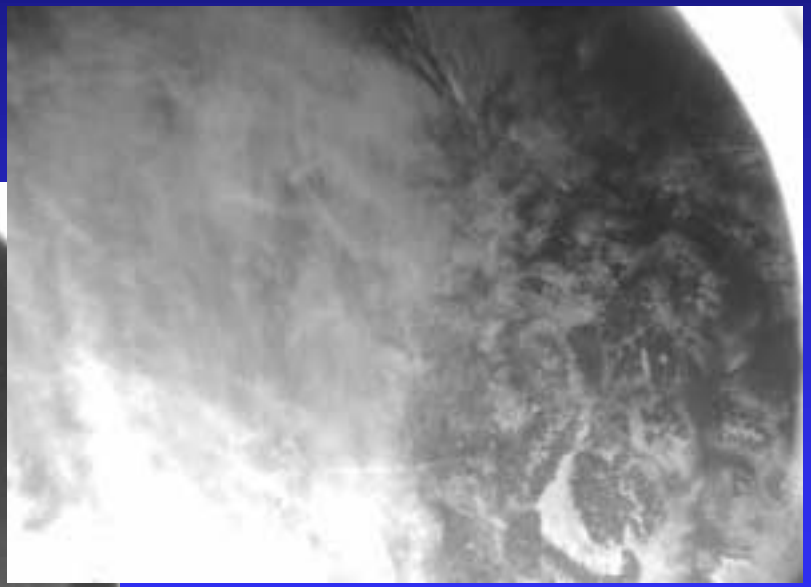
Lockheed Martin Athena

Launched September 29, 2001

Pictures From Space



1

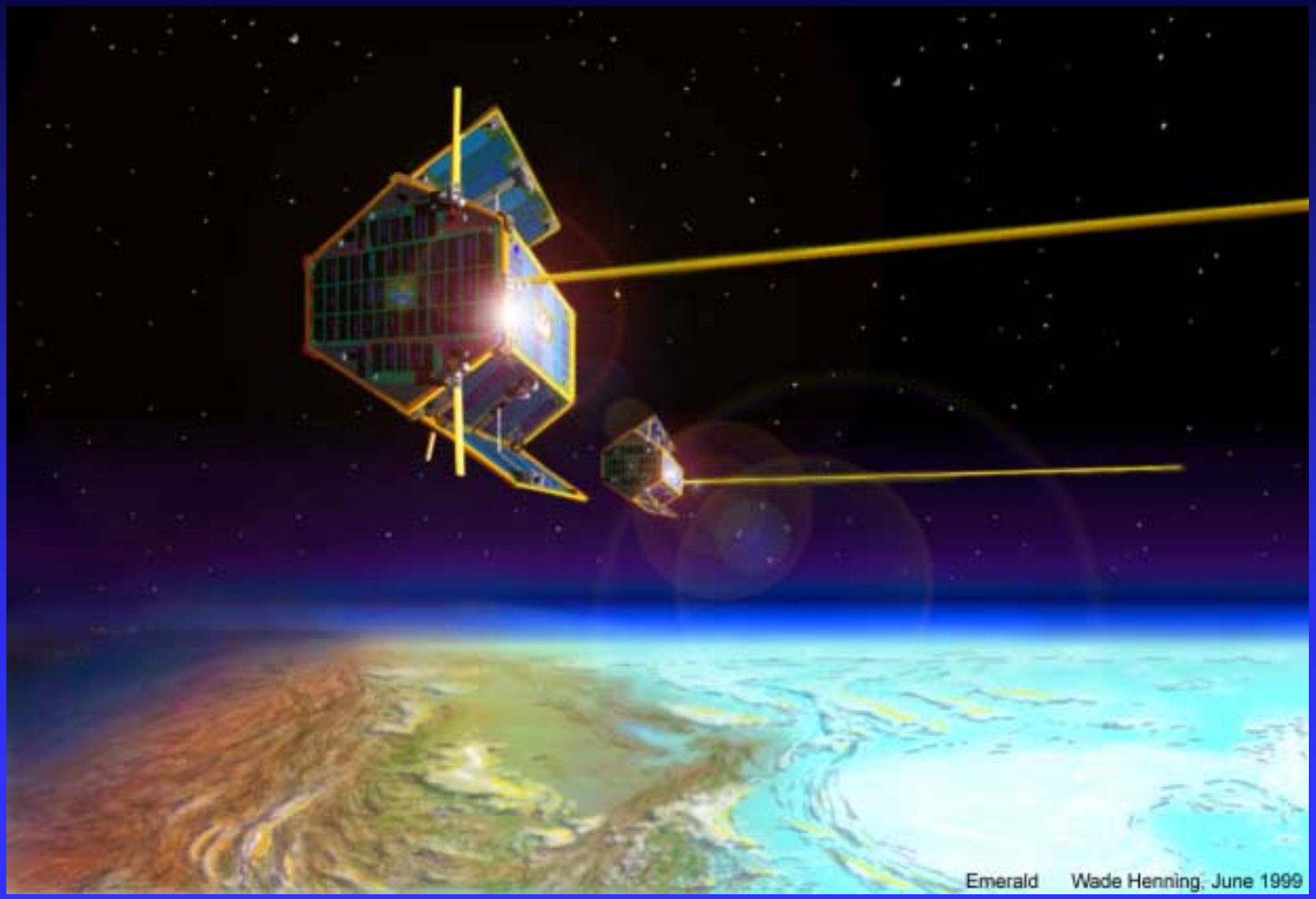


Mission Results

- **Test MEMS IR Sensors – 100%**
- **Test Voice Synthesizer– 100%**
- **Test Camera – 85%**
- **Education Value – 100%**
- **Student Leaning – One Chance in a Life Time**
- **Still Operational**

NanoSat Program

Emerald

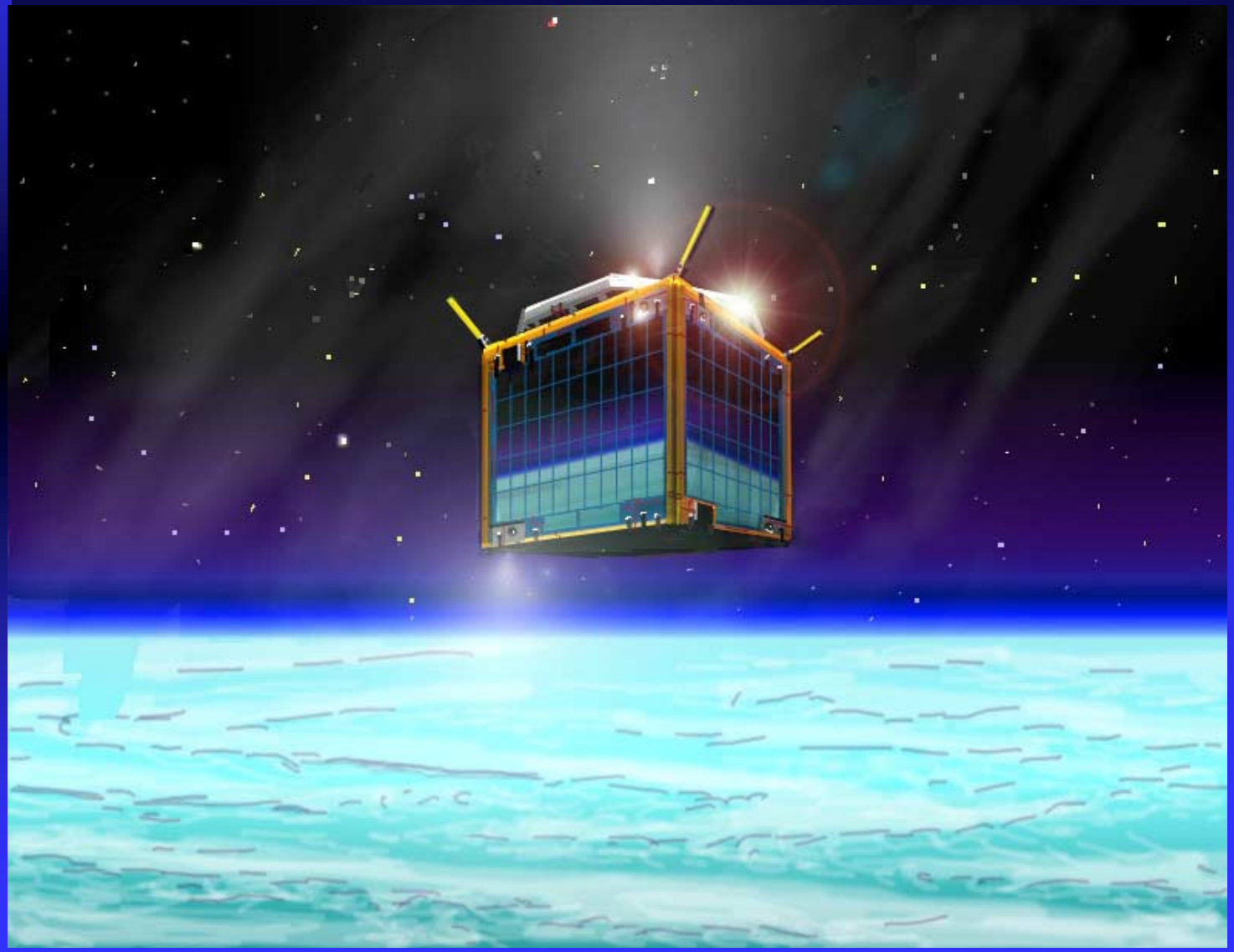


Emerald(2) – joint Stanford/Santa Clara University

Started:	April 1998
Completed:	Late 2002
Funding:	AFOSR GSFC
Mission:	Formation Flying VLF Radiation Detection Distributed Systems Bus
Launch:	??? ELV

Material Costs: $100,000/Each

Orion

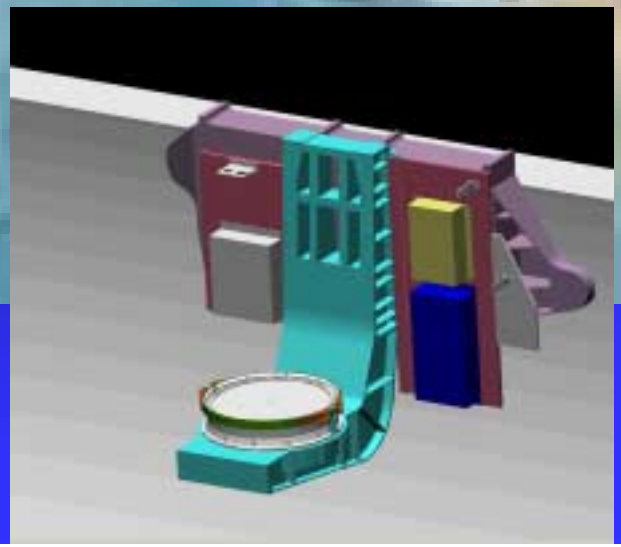


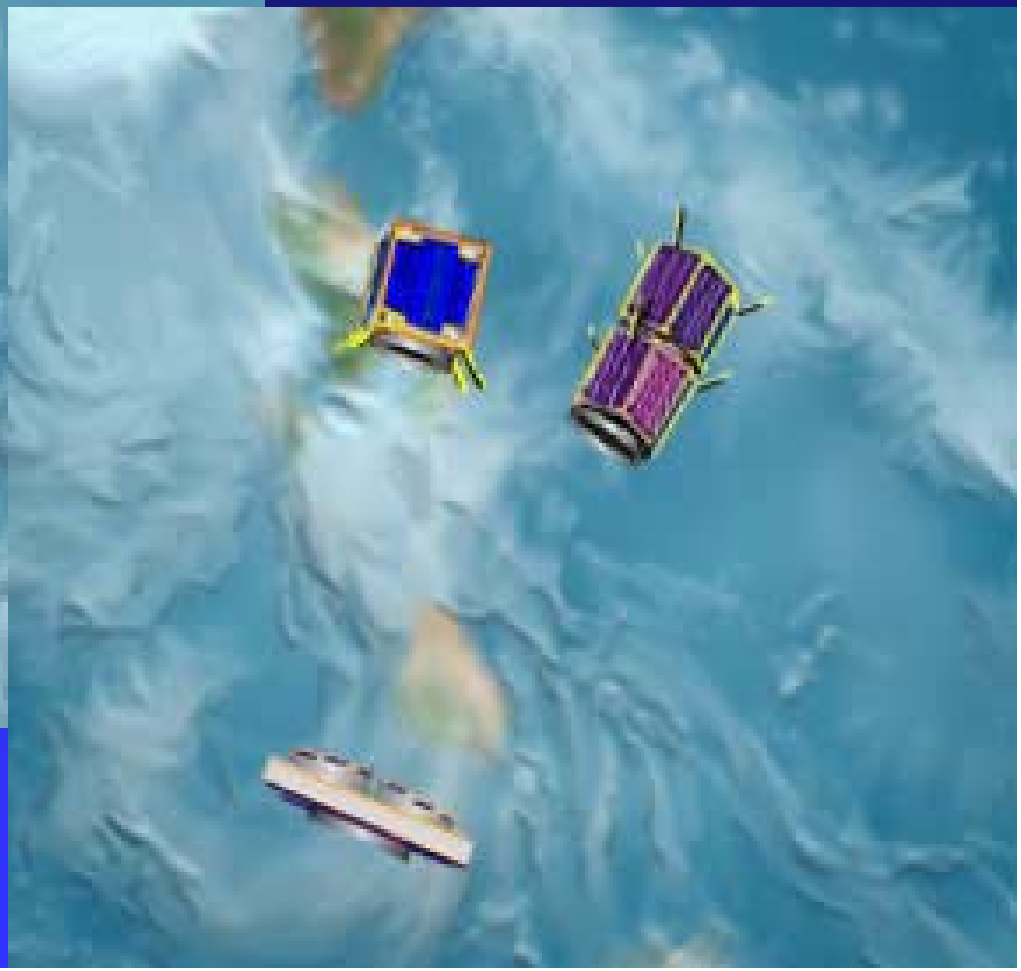
Orion

Started:	Sept. 1997
Completed:	?? – Transferred to MIT
Funding:	GSFC
Mission:	Formation Flying
Launch:	Late 2003 NASA Shuttle Kennedy Space Flight Center

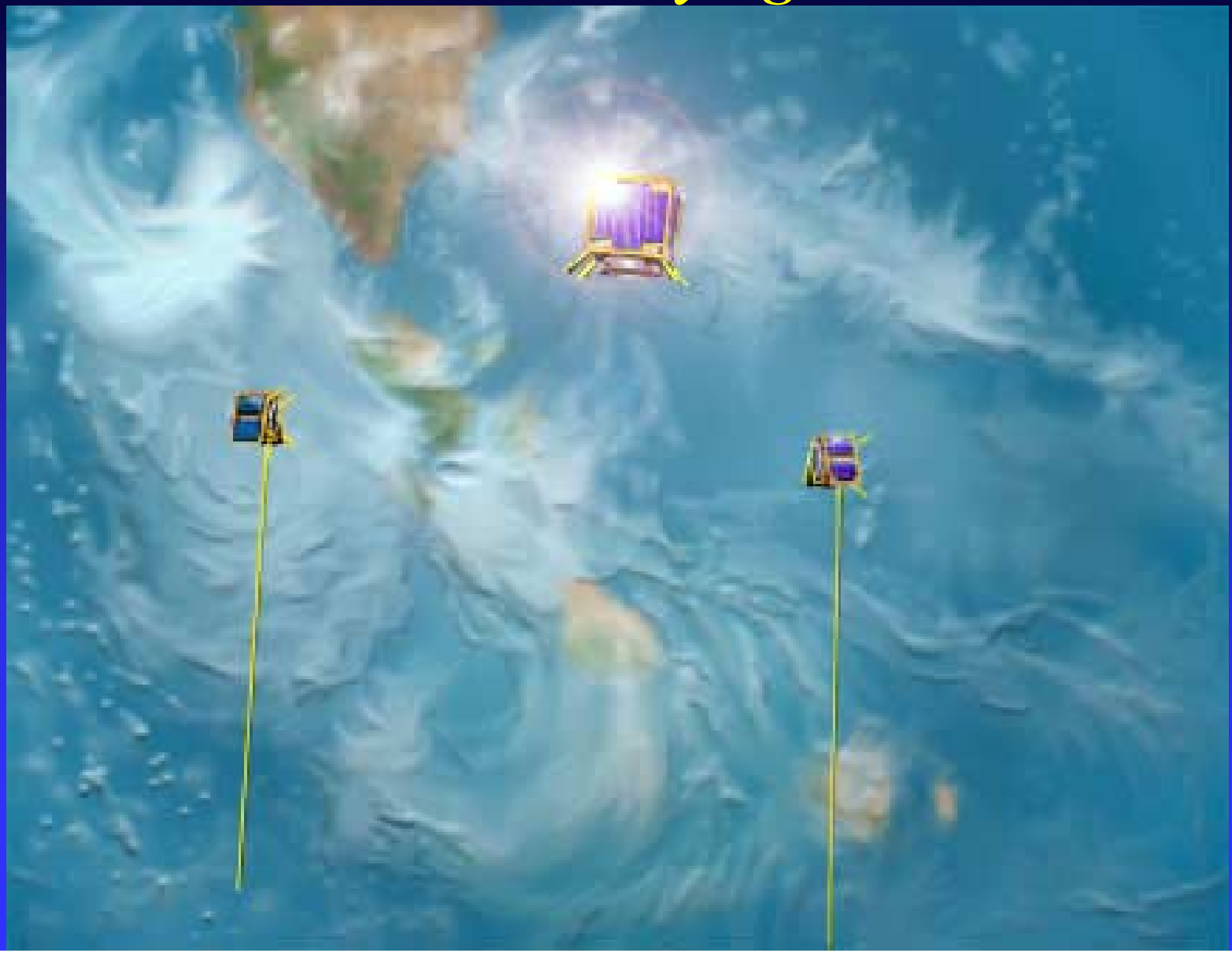
Material Costs: $150,000

Precision Formation Flying – Emerald/Orion

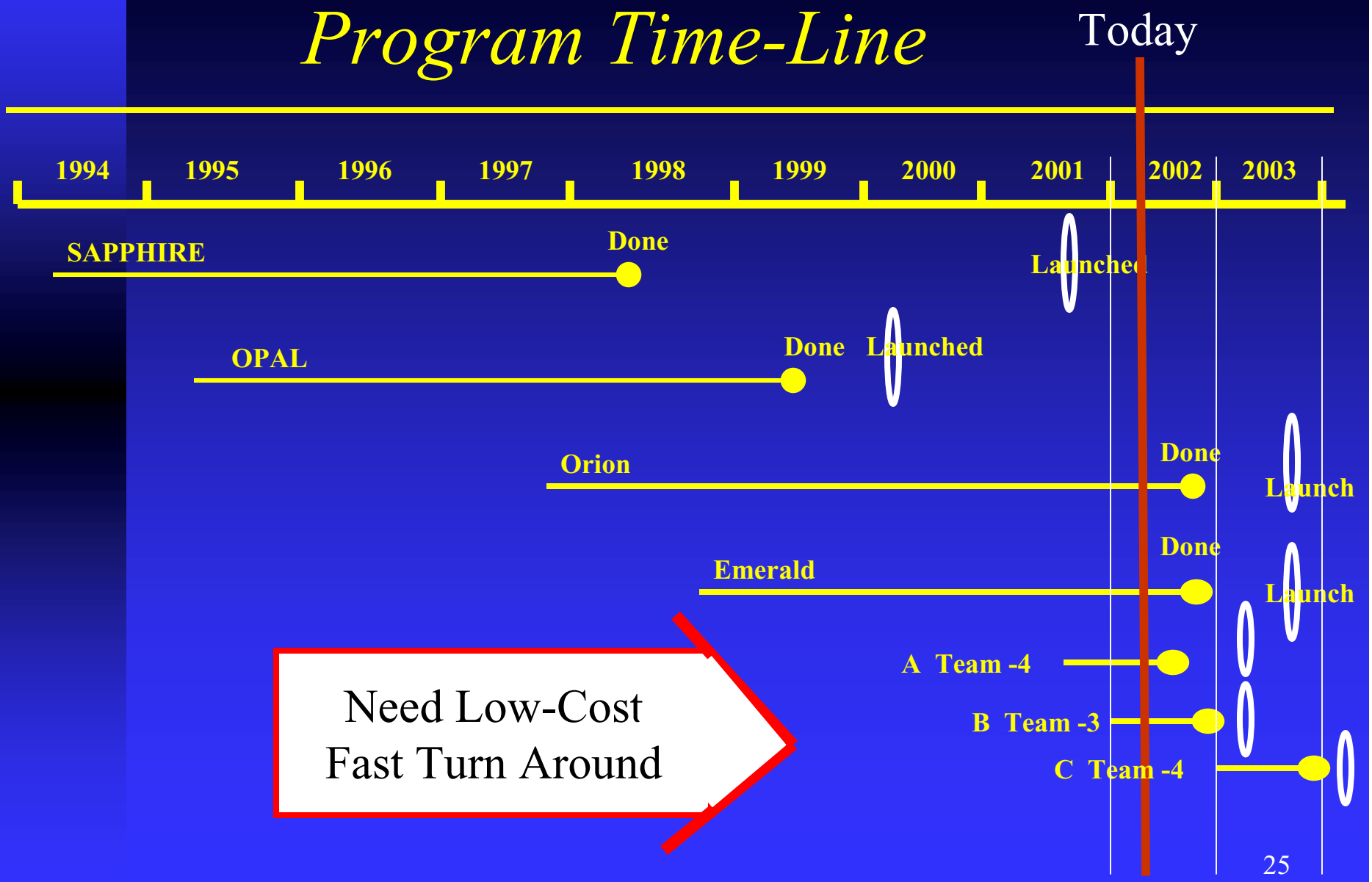




Precision Formation Flying – Emerald/Orion

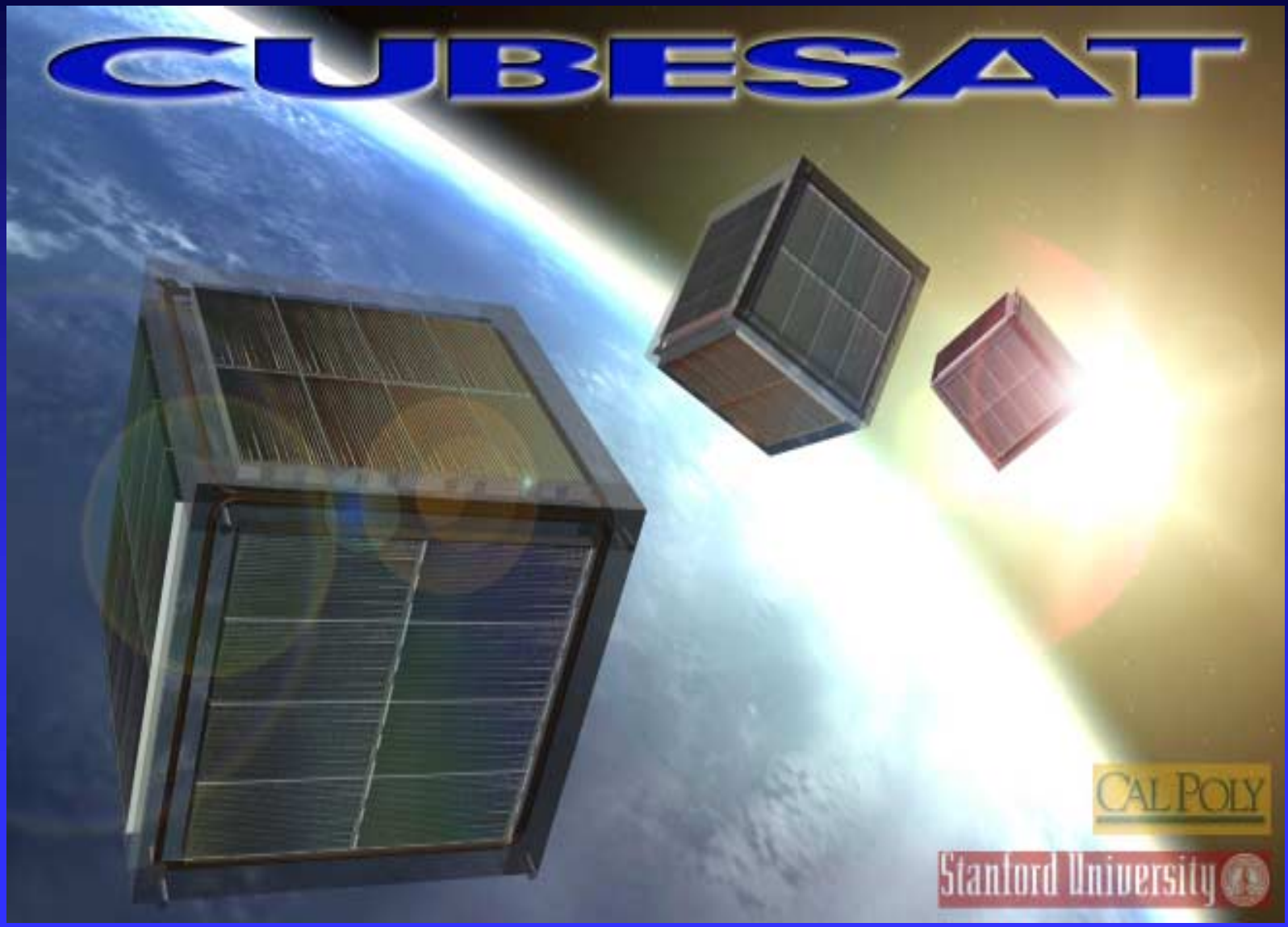


Program Time-Line



Changes in Program

CubeSat – The Next Generation



Current CubeSat Programs

A Team

- 20 Spacecraft Design Engineers
- Stanford Graduate Students
- Lockheed Martin – Sunnyvale
- Started Summer 2001
- Complete program Autumn 2002
- Four teams – four CubeSats
- All sponsored

A Team

Team #1

Sponsor: A Government Organization

Technology: SDM Structure

Launch: Shuttle spring 2003

Students: 5 MS

A Team

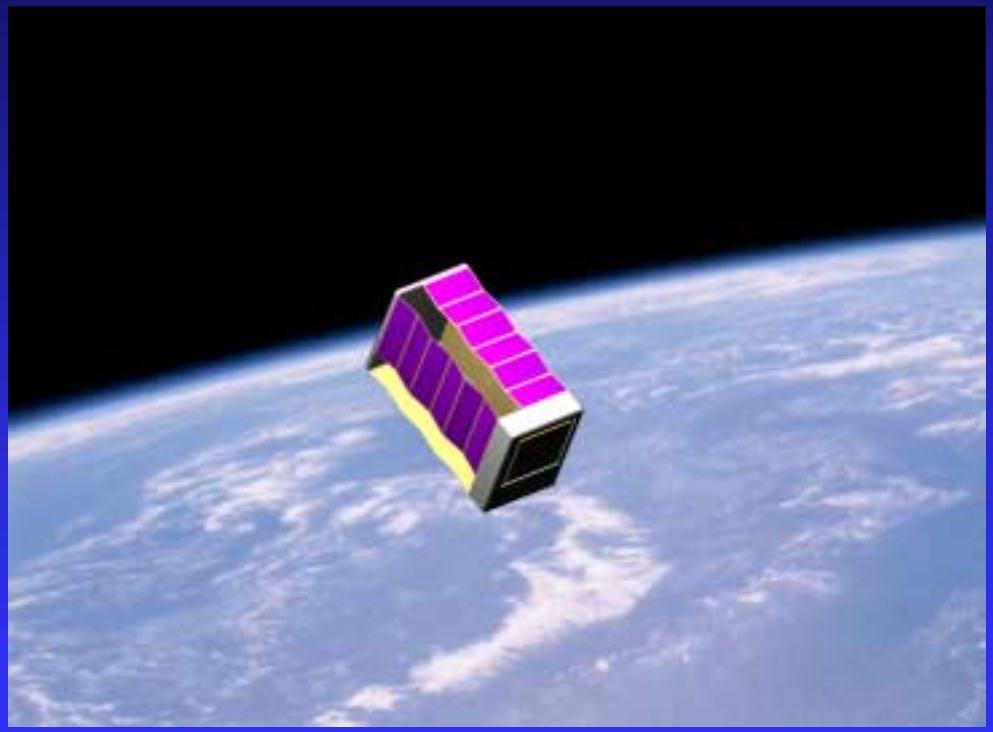
Team #2 & 3

Sponsor: The Aerospace Corp.

Technology: Power Mast

Launch: Shuttle – Spring 2003

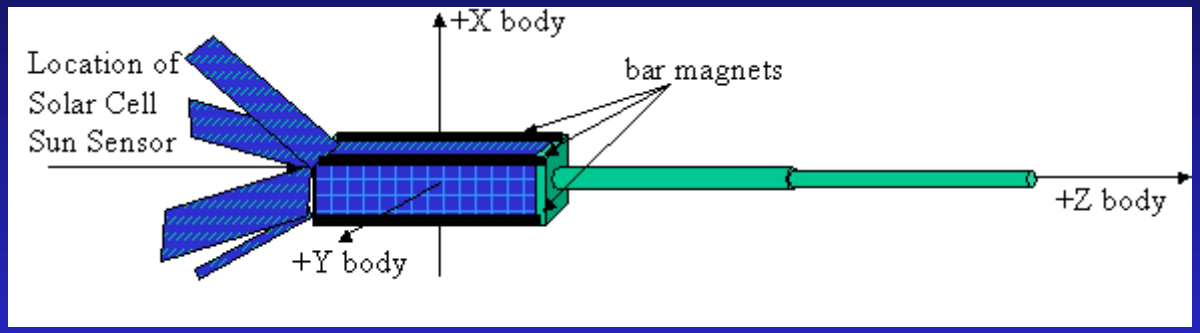
Students: 6 MS/team



Aerospace Power Mast

A Team

Team #4



QuakeFind NanoSat

Sponsor: Quake Find Inc.

Technology: Earth quake prediction

Launch: Dnepr Spring 2003

Students: 5 MS

B Team

- 15 Stanford Graduate Students
  - 4 Spacecraft Design Engineers
  - Space Systems/Loral – Palo Alto
- Started Winter 2002
- Complete program Autumn 2002
- Three teams – Three CubeSats
- No sponsors yet

Program Time-Line

Today

1994 1995 1996 1997 1998 1999 2000 2001 2002 2003

SAPPHIRE — Done — Launched

OPAL — Done — Launched

Orion — Done — ?? Launch

Emerald — Done — ?? Launch

A Team -4

B Team -3

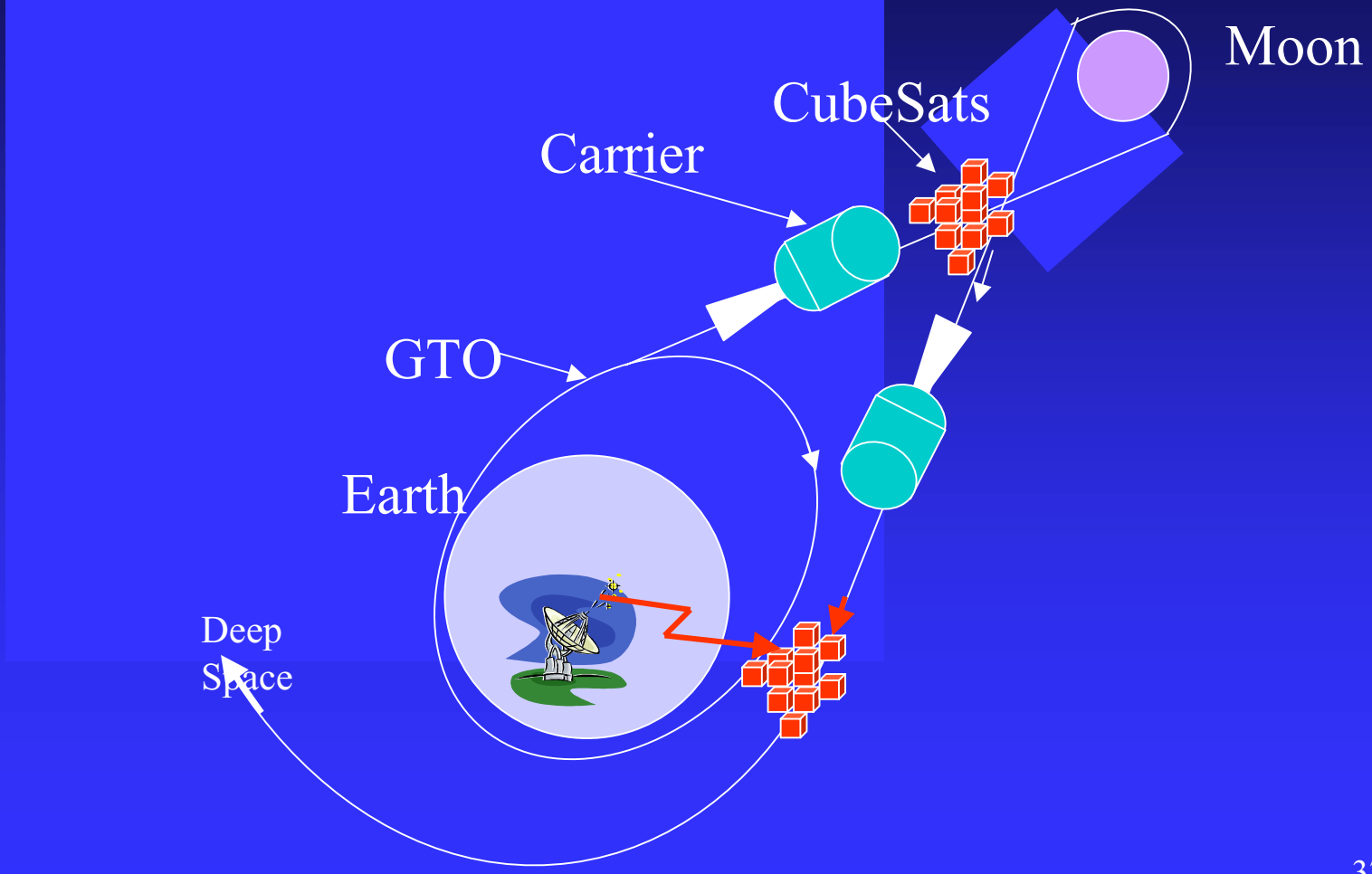
C Team -4

Have Low-Cost
Fast Turn Around

Future Projects

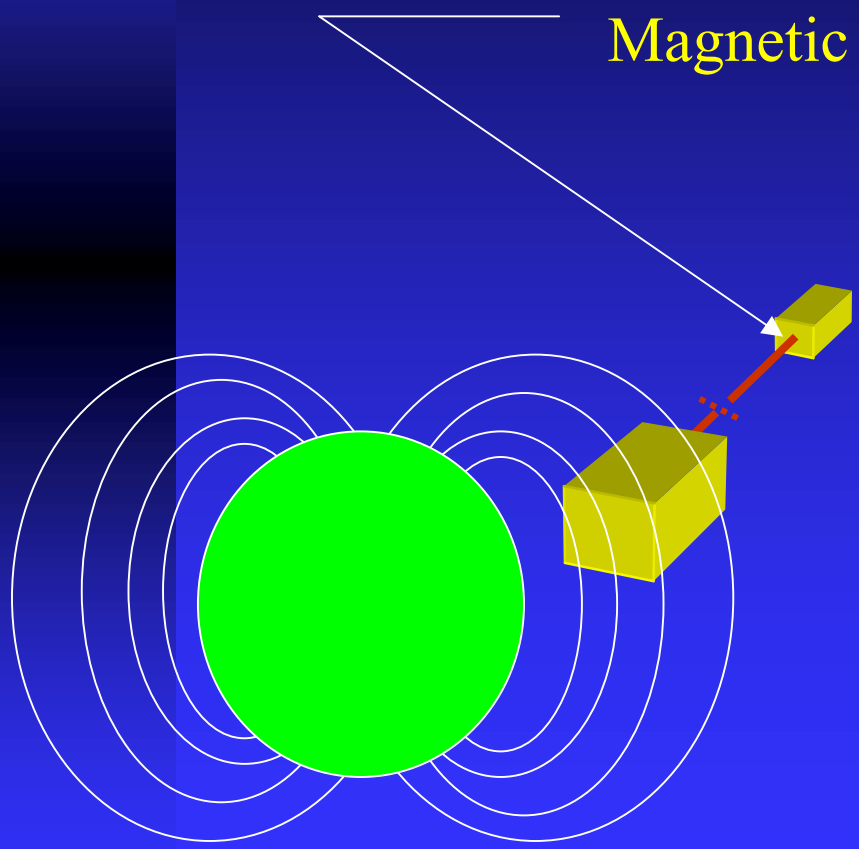
- ***CubeSats Constellations?***
- ***CubeSats to Moon?***
- ***CubeSats to Mars?***
- ***CubeSats for Asteroid & Comet Intercepts?***

Lunar Fly By & Return



Tethered CubeSat

Conductive Tether in Earth's Magnetic Field



Take power from tether
- **used for CubeSat operations**
- **will take energy from orbit cause deorbiting**

Send power to tether
- **orbit raising**
- **orbit maneuvers**

power usage/dissipation

National Program Time Line

Year	Project	Main Events/Year	Focused Grade Level
2002	CricketSat	2	5
2003	Suborbital 1	2	6
2004	LEO - 1	2	7
2005	Lunar Flyby & Return	1-2	8
2006	LEO - 2	1-2	Freshman
2007	Molnyia - 1	1-2	Sophomore
2008	Molnyia - 2	1-2	Junior
	Launch Mars CubeSats		
2009	Operating Molnyia - 2		Seniors
	Operate Mars Orbiters		

Conclusion

CubeSat Programs Work!

- *Low Cost*
- *Quick Turn-Around*
- *Challenging*
- *Motivational*
- *Super Educational*

Thank You